



**UNIVERSITY OF
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SCHOOL OF LEISURE SPORT AND TOURISM

Biomechanics of the Baseball Swing

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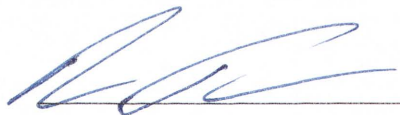
This thesis is submitted to fulfil the requirements for the degree Masters by Research
(Sport Studies) at the University of Technology, Sydney, August, 2010.

Certificate of Originality

I certify that the work in this thesis has not been previously submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledge within the text.

I also certify that the thesis has been written solely by me. Any help that I have received in my research work and the preparation of thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of candidate

A handwritten signature in blue ink, consisting of stylized, flowing letters, positioned above a horizontal line.

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Dedication

This thesis is dedicated to my parents. They are still the two most knowledgeable people I know and have always been there to support me through my studies.

Abstract

The purpose of this research was to describe the kinematics of the baseball swing. In particular, this study aimed to determine differences in bat swing kinematics in hitters of varying ability. Further, changes in swing pattern that occur when using bats of varying mass were also observed.

Twenty sub-elite male baseballers participated in the study (22.3 ± 5.3 yr, 1.82 ± 0.07 m, 83.5 ± 10.9 kg). Three baseball bats of equal length (0.838m) and varying mass (Bat₁ = 0.795kg, Bat₂ = 0.847kg, Bat₃ = 0.943kg) were used. Each subject performed 10 maximal swings with each bat at a ball on a hitting tee replicating a line drive. Infrared cameras obtained high speed three-dimensional data to quantify the biomechanics during the baseball swing. One-way ANOVA was used to determine kinematic differences between conditions. In addition, the participants were ranked prior to testing based on a novel coach's rating scale and seasonal batting average. They were subsequently separated into a relatively good group of hitters (n=10) and a relatively poor group of hitters (n=10) for comparison. Importantly, the two groups were significantly different in terms of coach's rating ($p < 0.01$) and batting average ($p < 0.05$).

The results showed a significant difference in maximum bat swing velocity ($p < 0.05$) with good hitters having a higher velocity ($36.8 \text{ m}\cdot\text{s}^{-1}$) in comparison to relatively poor hitters ($33.8 \text{ m}\cdot\text{s}^{-1}$). Left elbow maximum angular velocity was significantly higher (35.9%) amongst relatively good hitters ($p < 0.05$). Good hitters also had a right knee angle of 106° at ball contact which was significantly ($p < 0.05$) higher than relatively poor hitters (100°). There were no between-group differences for wrist and hip joint velocities at ball contact.

The results also showed a difference in maximum bat swing velocity ($p < 0.01$) between Bat₁ ($36.0 \text{ m}\cdot\text{s}^{-1}$) and Bat₃ ($34.4 \text{ m}\cdot\text{s}^{-1}$). Resultant ball velocity was 17% higher using Bat₁ compared to Bat₃ ($p < 0.05$). Subject head movement was lower using Bat₁ (8 cm) when compared to Bat₃ (10 cm). Maximum linear left hip velocity was significantly higher ($p < 0.01$) when using Bat₃ compared to other bats. In contrast, maximum linear right hip velocity was lower ($p < 0.01$) when using Bat₃.

This study established that bat swing velocity is a key characteristic of the baseball swing when identifying skill level and performance between hitters. Additionally, good hitters display greater lead elbow maximum angular velocity. Future research should develop and evaluate specific baseball training programs designed primarily to improve these two aspects of the baseball swing. Further, this study has identified aspects of the baseball swing that differ when using bats of varying mass. Notably, a relationship exists between bat mass and hip linear velocity which could be a

potential mechanism for underlying training effects. Further studies are needed to determine acute and longitudinal kinematic effects of using bats of varying mass.

Table of contents

Certificate of Originalityii

Acknowledgements..... iii

Dedication v

Abstract.....vi

Table of contentsix

List of Tablesxii

List of Figures.....xiv

List of Equations xv

List of Abbreviationsxvi

List of Publications..... xviii

CHAPTER 1 - INTRODUCTION 1

1.1 Background.....2

1.2 Statement of the Problem6

1.3 Research Hypothesis7

1.4 Purpose and Significance of the Project.....7

1.5 Limitations9

1.6 Delimitations9

CHAPTER 2 - REVIEW OF LITERATURE	10
2.1 Overview	11
2.2 The Game of Baseball.....	11
2.3 Biomechanics of Baseball Batting.....	15
2.3.1 Biomechanics of the Baseball Swing	15
2.3.1.1 Preparation.....	19
2.3.1.2 Initiation.....	19
2.3.1.3 Load	20
2.3.1.4 Shift and Transfer	20
2.3.1.5 Contact.....	22
2.3.1.6 Summary.....	23
2.4 Characteristics of the Baseball Bat.....	24
2.4.1 Mass and Length	27
2.4.2 Moment of Inertia.....	27
2.4.3 Coefficient of Restitution	30
2.4.4 Aluminium vs. Wood	31
2.5 Bat Swing Velocity	32
2.5.1 Acute Methods for Improving Bat Swing Velocity	33
2.5.2 Training Methods for Improving Bat Swing Velocity	36
2.6 Summary.....	41
 CHAPTER 3 - METHODS	 43
3.1 Overview	44
3.2 Participants.....	44
3.3 Testing Procedures.....	46
3.4 Data Collection	49
3.5 Data Processing	51
3.6 Data Analysis	53

CHAPTER 4 - RESULTS 55

4.1 Overview56

4.2 Relatively Good vs. Relatively Poor Hitters.....56

4.3 Correlations between bat swing kinematics.....60

4.4 Manipulating Bat Mass.....62

4.5 Summary of Key Results66

CHAPTER 5 - DISCUSSION 68

5.1 Overview69

5.2 Relatively Good vs. Relatively Poor Hitters70

5.3 Manipulating Bat Mass74

5.4 Summary78

CHAPTER 6 - CONCLUSIONS AND RECOMMENDATIONS 79

6.1 Overview80

6.2 Summary of Major Findings and Conclusions.....80

6.3 Directions for future research.....82

REFERENCE LIST 85

APPENDICES 95

List of Tables

Table 2.1 – Elite Hitter’s Swing Characteristics	18
Table 2.2 – Bat Velocity after warm-up with bats of varying mass (adapted from De Renne et al. (1992, p. 216))	35
Table 2.3 – Group mean bat swing velocities and percent change (Sergo & Boatwright, 1993)	39
Table 2.4 – Training Schedule (DeRenne et al., 1995, pp. 248)	40
Table 2.5 – Group mean bat swing velocities and percent change (DeRenne et al., 1995)	41
Table 3.1 – Biomechanical variables calculated for the bat swing	52
Table 4.1 – Kinanthropometric data for each group (mean \pm SD)	57
Table 4.2 – Results for all participants and comparative data for the good group and poor group for bat swing kinematics (mean \pm SD)	58
Table 4.3 – Upper body bat swing kinematics (mean \pm SD)	58
Table 4.4 – Lower body bat swing kinematics (mean \pm SD)	59
Table 4.5 – Pearson’s correlation data for the relationship between bat and ball variables (A = Maximum Bat Linear Velocity, B = Bat Linear Velocity at Contact, C = Maximum Ball Linear Velocity)	61

Table 4.6 – Pearson’s correlation data for left elbow kinematics 61

Table 4.7 – Pearson’s correlation data for hip kinematics 62

Table 4.8 – Kinematic comparisons between bats of different mass.
Data is mean \pm SD 65

List of Figures

Figure 2.1 – Participation Rates in Baseball and Cricket – 2009 (ASC, 2009)	14
Figure 2.2 – Phases of the Swing	17
Figure 2.3 – Theoretical effects of increased bat swing velocity. Assuming a pitched ball speed of 40m.s^{-1} , a take off angle of 35 degrees, and neglecting wind and air resistance	33
Figure 3.1 – Marker Placement on the Subject	47
Figure 3.2 – Baseball Bats	49
Figure 3.3 – Camera set-up surrounding batting tee and hitting net	51
Figure 4.1 – Bat swing velocities (+ SD) and resultant ball velocity (+ SD) between bats	63
Figure 4.2 – Left and right hip velocities (+ SD) for each bat	64

List of Equations

Equation 1 – Rotational Inertia	27
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$$I = (1 / 4)MR^2 + (1 / 12)ML^2$$

Equation 2 – Moment of Inertia	28
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$$I_o = \frac{T^2 \bullet w \bullet r}{4\pi^2}$$

Equation 3 – Radius of Gyration	28
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$$k = \sqrt{\frac{I_o}{m}}$$

Equation 4 – Centre of Percussion	29
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$$q = \frac{k^2}{r}$$

Equation 5 – Coefficient of Restitution	30
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$$e_o = - \frac{v'-V'}{v-V}$$

List of Abbreviations

3D	Three Dimensional
ANOVA	Analysis of Variance
BP	Batting Practice Group
BSV	Bat Swing Velocity
BSV_{con}	Bat Swing Velocity at Contact
BSV_{max}	Maximum Bat Swing Velocity
BV_{max}	Maximum Resultant Ball Velocity
CG	Control Group
COP	Centre of Percussion
COR	Coefficient of Restitution
°	Degrees
°·s⁻¹	Degrees per second
DS	Dry Swing Group
Hz	Hertz
ICC	Interclass Correlation
in	Inches
kg	Kilograms
KP	Kilopond
LEAV_{max}	Maximum Left Elbow Angular Velocity
m	Metres
m·s⁻¹	Metres per second
MLB	Major League Baseball

MOI	Moment of Inertia
NCAA	National Collegiate Athletic Association
NSWML	New South Wales Major League
oz	Ounces
RPM	Revolutions per minute
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
TEM	Technical Error of Measurement
USA	United States of America
WBC	World Baseball Classic
yrs	Years

List of Publications

Inkster, B., Murphy, A., Bower, R. & Watsford, M. Differences in the kinematics of the baseball swing between hitters of varying skill. (In Press: *Medicine and Science in Sports and Exercise*).

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